Note on Vertical Test Results of Cavity NR-4

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Cavity NR-4, a single-cell Tesla-shape cavity manufactured by the Niowave-Roark collaboration, was originally tested at both Cornell and FNAL after undergoing BCP processing (at Cornell) and then HPR and assembly (at both Cornell and FNAL). During these earlier tests, the cavity was limited to gradients of about 27.4 – 28.7 MV/m, and exhibited strong Q-drop (while being essentially FE-free).

This cavity was subsequently chosen to be provided to the ABLE Electropolishing Co. for use in developing an industrial cavity processing capability. The cavity was electropolished at ABLE, then returned to FNAL for optical inspection, then transported to ANL where it was further processed (HPR) and assembled for test. It was then transported back to FNAL, to the VCTF at IB1, where it was mounted on the test stand, and connected to the pumping system. Note that it did not receive the now-customary 120° C bake for electropolished cavities.

The cavity was cooled down to 2.00K so that CW measurements of Q_0 vs E could be performed. The cavity's field probe was calibrated at field levels of about 6MV/m, and yielded a value of $2.79 \pm 0.05 \times 10^{12}$ (Q_2). The decay measurements (τ) used to calculate Q_2 were within 2.2% of each other (mean value = 0.503 s), and the calculated values of Q_2 were consistent to within 1.9%. The input coupling was determined to be 6.58×10^9 (Q_1), and the cavity was overcoupled throughout most of the test (except at highest field levels).

Low field Q_0 was found to be about 1.1×10^{10}, and was initially uniform. Light field emission began at a gradient of about 9MV/m, and while some processing was observed, the cavity continued to exhibit light field emission which had a moderate impact on the cavity Q_0 until a gradient of about 20MV/m. At that point, FE began to increase markedly, with a concomitant decrease in Q_0 (see Figure 1). The cavity was ultimately limited to 30.1 MV/m, due to low Q_0 resulting from FE (the Q_0 at maximum gradient was only 1.13×10^9). At maximum field, P_{input} was 176W, with P_{loss} about 103W. This is a significant power loss for a single-cell cavity, and is likely due to a combination of FE and lack of a 120° bake.

While this cavity did not meet the ILC specifications, its performance, as the first industrially electropolished 1.3GHz cavity in the United States, is encouraging (see Figure 2) – and surprising given that the appearance of the cavity interior was not indicative of a high-quality RF surface. Since this cavity was performance limited to some degree by FE and Q-drop, it is suggested that the cavity be re-tested after another processing cycle (HPR only), including a 120°C bakeout for 48hrs. It is important to note that while the 120°C bakeout will improve the high-field Q_0 behaviour, it will probably not have an effect on the low field Q_0, which remains a concern.

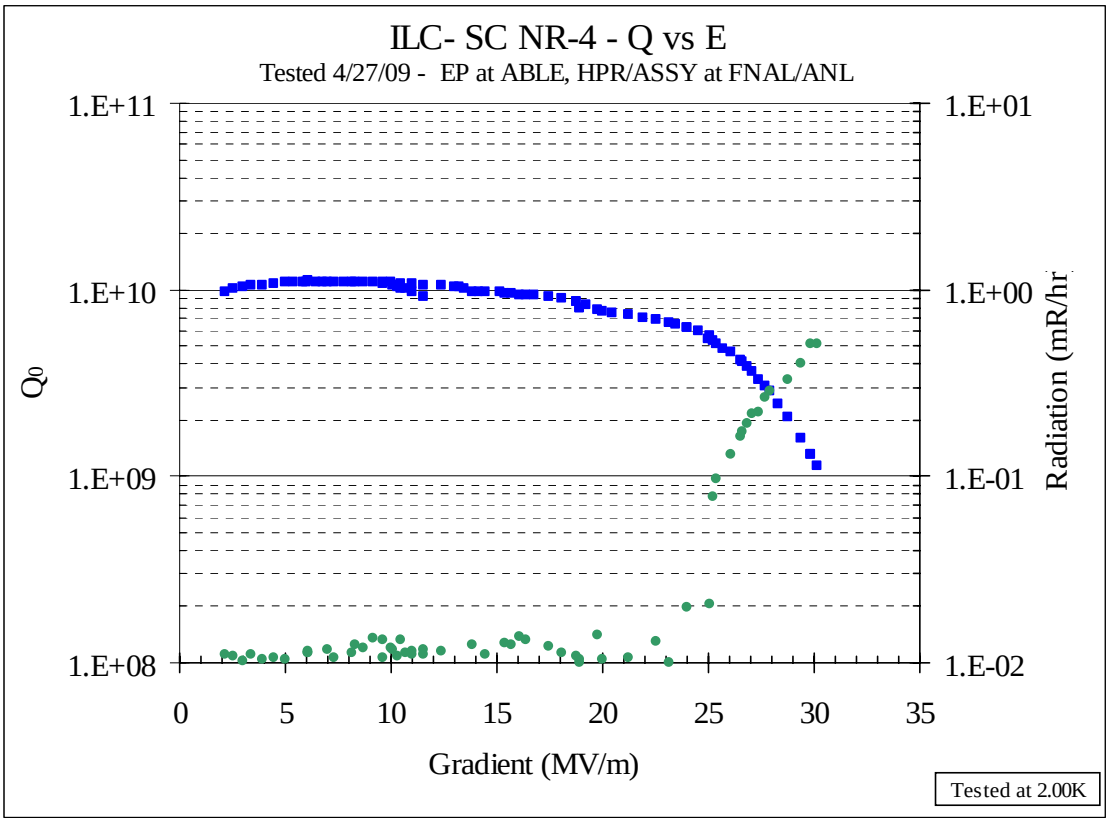

Figure 1.) Q_0 vs E run at 2K.

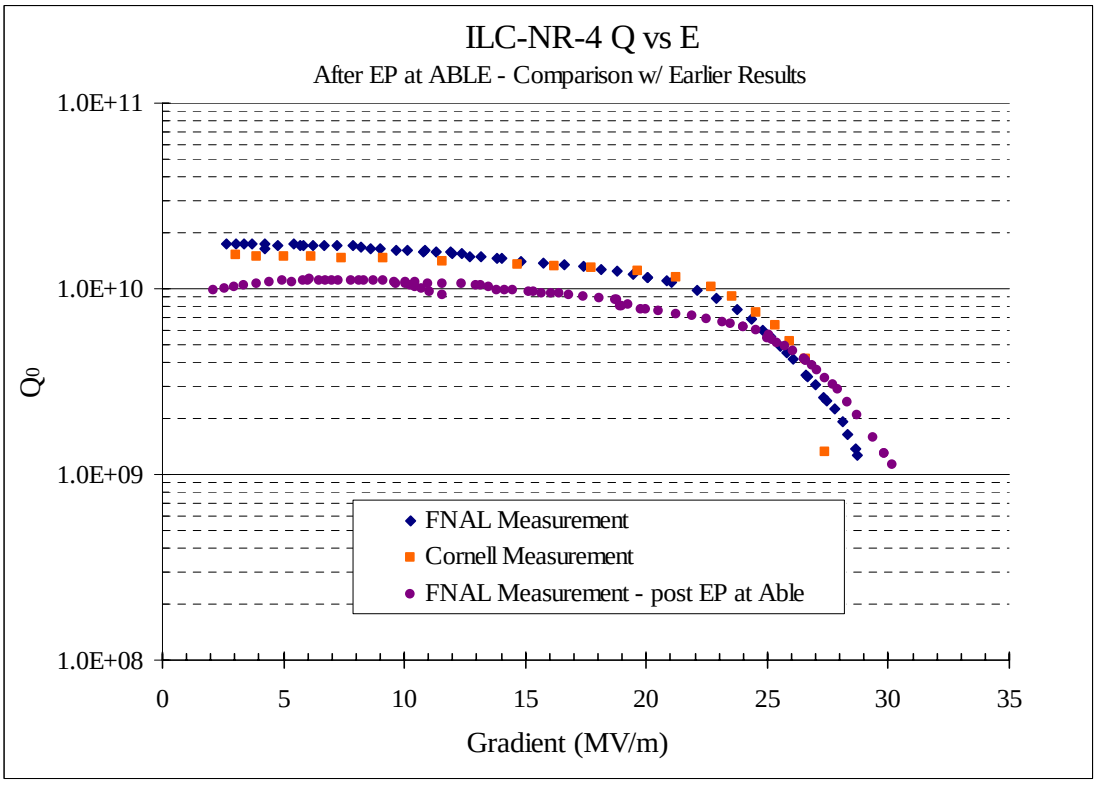

Figure 2.) Comparison of cavity performance before and after EP at ABLE Electropolishing.